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EXAMINER	
THANGAVELU, KANDASAMY	

ART UNIT	PAPER NUMBER
2123	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/814,299	WESSOL ET AL.
	Examiner	Art Unit
	Kandasamy Thangavelu	2123

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 March 2001*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-43* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-10,13-23 and 25-43* is/are rejected.

7)☒ Claim(s) *11,12 and 24* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *21 March 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

.DETAILED ACTION

1. Claims 1-43 of the application have been examined.

Drawings

2. The drawings submitted on March 21, 2001 are accepted.

Claim Objections

3. The following is a quotation of 37 C.F.R § 1.75 (d)(1):

> The claim or claims must conform to the invention as set forth in the remainder of the specification and terms and phrases in the claims must find clear support or antecedent basis in the description so that the meaning of the terms in the claims may be ascertainable by reference to the description.

4. Claims 1 and 34 are objected to because of the following informalities:

Claim 1, Lines 1-2, "A method for tracking a particle through a geometric model, the steps comprising" appears to be incorrect and it appears it should be "A method for tracking a particle through a geometric model, said method comprising".

Claim 34, Lines 2-3, "where along the movement the next element is substantially different from the material of the starting element" appears to be incorrect and it appears it should be "where along the movement the material of the next element is substantially different from the material of the starting element".

Appropriate corrections are required.

Double Patenting

5. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and, *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

6. Claim 1 is rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 1 and 8 of U.S. Patent No. 6,175,761. Although the conflicting claims are not identical, they are not patentably distinct from each other.

Claim 1, teaches a method for tracking a particle through a geometric model, the steps comprising:

arranging a plurality of substantially uniform volume elements into said geometric model;

describing a movement of said particle through said geometric model with a particle track; and

traversing said particle along said particle track from one said uniform volume element to another said uniform volume element in integer based increments.

Claim 1 of the '761 patent does not expressly teach "traversing said particle along said particle track from one said uniform volume element to another said uniform volume element in integer based increments". However, Claim 1 of the '761 patent teaches, "traversing said particle along said particle track in integer based increments along said primary direction of movement" and Claim 8 of the '761 patent teaches "said particle traverses along said particle track from a previous element of said uniform volume elements to a next element of said uniform volume elements" as part of a method for tracking a particle through a geometric model, because "traversing said particle along said particle track in integer based increments along said primary direction of movement" included in claim 1 of '761 patent involves "traversing said particle along said particle track from one said uniform volume element to another said uniform volume element in integer based increments". It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to arrive at claim 1 of the application, by adding to the method of Claim 1 of the '761 patent "traversing said particle along said particle track from one said uniform volume element to another said uniform volume element" of Claim 8 of the '761

patent, because "traversing said particle along said particle track in integer based increments along said primary direction of movement" included in claim 1 of '761 patent would involve "traversing said particle along said particle track from one said uniform volume element to another said uniform volume element in integer based increments".

7. Claims 2-7 and 9-12 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 2-7 and 9-12 of U.S. Patent No. 6,175,761. Although the conflicting claims are not identical, they are not patentably distinct from each other.

Claims 2-7 and 9-12 are based on independent claim 1. However, their limitations in the dependent claims are exactly same as the limitations of Claims 2-7 and 9-12 of the '761 patent. Therefore, the Claims 2-7 and 9-12 of the application appear to be different from Claims 2-7 and 9-12 of the '761 patent only because the base claim 1 is different from the base claim 1 of the '761 patent. However, the independent claim 1 is obvious from claims 1 and 8 of the '761 patent. Therefore, Claims 2-7 and 9-12 of the application are not patentably distinct from Claims 2-7 and 9-12 of the '761 patent.

8. Claim 20 is rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 20 and 8 of U.S. Patent No. 6,175,761. Although the conflicting claims are not identical, they are not patentably distinct from each other.

Claim 20, teaches a computer readable medium having computer executable instructions for tracking a movement of a particle through a geometric model, the computer executable instructions for performing the steps of:

arranging a plurality of substantially uniform volume elements into said geometric model;

mapping a material associated with each said uniform volume element to an array, at least one of said uniform volume elements being mapped to a radiation source;

projecting said movement of said particle through said geometric model with a particle track beginning in a starting element of said uniform volume elements and traversing to a next element of said uniform volume elements; and

traversing said particle along said particle track in integer based increments until said material of said next element is substantially different from said material of said starting element.

Claim 20 of the '761 patent does not expressly teach "projecting said movement of said particle through said geometric model with a particle track beginning in a starting element of said uniform volume elements and traversing to a next element of said uniform volume elements; and

traversing said particle along said particle track in integer based increments until said material of said next element is substantially different from said material of said starting element". However, Claim 20 of the '761 patent teaches "projecting said movement of said particle through said geometric model with a particle track beginning in a starting element of

said uniform volume elements and traversing to a next element of said uniform volume elements, said particle track having a primary direction of movement; and

traversing said particle along said particle track in integer based increments along said primary direction of movement until said material of said next element is substantially different from said material of said starting element" as part of a method for tracking a particle through a geometric model, because "projecting said movement of said particle through said geometric model with a particle track beginning in a starting element of said uniform volume elements and traversing to a next element of said uniform volume elements" included in claim 20 of the application includes "said particle track having a primary direction of movement"; and "traversing said particle along said particle track in integer based increments until said material of said next element is substantially different from said material of said starting element" included in claim 20 of the application includes "along said primary direction of movement". It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to arrive at Claim 20 of the application, by dropping the reference to primary direction of Claim 20 of the '761 patent, because "projecting said movement of said particle through said geometric model with a particle track beginning in a starting element of said uniform volume elements and traversing to a next element of said uniform volume elements" included in claim 20 of the application would include "said particle track having a primary direction of movement"; and "traversing said particle along said particle track in integer based increments until said material of said next element is substantially different from said material of said starting element" included in claim 20 of the application would include "along said primary direction of movement".

9. Claims 21-28 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 21-28 of U.S. Patent No. 6,175,761. Although the conflicting claims are not identical, they are not patentably distinct from each other.

Claims 21-28 are based on independent claim 20. However, their limitations in the dependent claims are exactly same as the limitations of Claims 21-28 of the '761 patent. Therefore, the Claims 21-28 of the application appear to be different from Claims 21-28 of the '761 patent only because the base claim 20 is different from the base claim 20 of the '761 patent. However, the independent claim 201 is obvious from claims 20 and 8 of the '761 patent. Therefore, Claims 21-28 of the application are not patentably distinct from Claims 21-28 of the '761 patent.

Claim Rejections - 35 USC § 101

10. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

11. Claims 20-30, 35 and 43 are rejected under 35 U.S.C. 101 because the claimed inventions are directed to non-statutory subject matter.

Independent claim 20 recites a computer readable medium having computer executable

instructions for tracking a movement of a particle through a geometric model. The limitations recited in claim contain the steps implemented in the computer program which is not statutory subject matter. To be statutory, the computer readable medium should include computer executable instructions which when executed in a computer performs a process comprising the steps included in the limitations.

Dependent claims 21-28 recite a computer readable medium having computer executable instructions. The limitations recited in claim contain the steps implemented in the computer program which is not statutory subject matter. To be statutory, the computer readable medium should include computer executable instructions which when executed in a computer performs a process comprising the steps included in the dependent claims.

Independent claim 29 recites a computer readable medium having computer executable instructions for computationally enlarging a radiation distribution of a treatment volume. The limitations recited in claim contain the steps implemented in the computer program which is not statutory subject matter. To be statutory, the computer readable medium should include computer executable instructions which when executed in a computer performs a process comprising the steps included in the limitations.

Independent claim 30 recites a computer readable medium having computer executable modules for enlarging a radiation distribution of a treatment volume. The limitations recited in claim contain the modules implemented in the computer program which is not statutory subject matter. To be statutory, the computer readable medium should include computer executable modules including computer executable instructions which when executed in a computer performs a process executed by the modules included in the limitations.

Independent claim 35 recites a computer readable medium having computer executable instructions for performing the steps as recited in claim 31. The limitations recited in claim contain the instructions implemented in the computer program which is not statutory subject matter. To be statutory, the computer readable medium should include computer executable instructions which when executed in a computer performs a process executed by the instructions included in the limitations.

Independent claim 43 recites a computer readable medium having computer executable instructions for enlarging a radiation distribution of a treatment volume. The limitations recited in claim contain the instructions implemented in the computer program which is not statutory subject matter. To be statutory, the computer readable medium should include computer executable instructions which when executed in a computer performs a process executed by the instructions included in the limitations.

12. Claim 20 would be statutory if it is rewritten as:

A computer readable medium having computer executable instructions for tracking a movement of a particle through a geometric model which when executed on a computer perform a process for tracking a movement of a particle through a geometric model, the process comprising the steps of:

arranging a plurality of substantially uniform volume elements into the geometric model;

....

Claims 21-28 would be statutory if claim 20 is rewritten as above.

Claim 29 would be statutory if it is rewritten as:

A computer readable medium having computer executable instructions for computationally enlarging a radiation distribution of a treatment volume irradiated during a radiation therapy having a radiation source which when executed on a computer perform a process for computationally enlarging a radiation distribution of a treatment volume irradiated during a radiation therapy having a radiation source, the process comprising the steps of:

reading a medical image of the treatment volume, the medical image containing a plurality of pixels of information;

....

Claim 30 would be statutory if it is rewritten as:

A computer readable medium having computer executable modules including computer executable instructions for enlarging a radiation distribution of a treatment volume irradiated during a radiation therapy having a radiation source which when executed on a computer perform a process for enlarging a radiation distribution of a treatment volume irradiated during a radiation therapy having a radiation source, the modules comprising:

a reader module including computer executable instructions for converting a plurality of pixels of information contained in a medical image into a corresponding plurality of uniform volume elements;

....

Claim 35 would be statutory if it is rewritten as:

A computer readable medium having computer executable instructions which when executed on a computer, perform a process comprising the steps as recited in claim 31.

Claim 43 would be statutory if it is rewritten as:

A computer readable medium having computer executable instructions for computationally enlarging a radiation distribution of a treatment volume irradiated during a radiation therapy having a radiation source which when executed on a computer perform a process for computationally enlarging a radiation distribution of a treatment volume irradiated during a radiation therapy having a radiation source, the process comprising the steps of:

reading a medical image of the treatment volume, the medical image containing a plurality of pixels of information;

. . . .

Claim Rejections - 35 USC § 103

13. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

14. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

15. Claims 1 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475).

15.1 **Silver** teaches analytical imaging system and process. Specifically, as per claim 1, **Silver** teaches a method for tracking a particle through a geometric model (CL12, L38-48; CL13, L3-17); the steps comprising:

describing a movement of the particle through the geometric model with a particle track (CL13, L3-17).

Silver does not expressly teach arranging a plurality of substantially uniform volume elements into the geometric model; and traversing the particle along the particle track from one uniform volume element to another uniform volume element in integer based increments. **Kaufman et al.** teaches arranging a plurality of substantially uniform volume elements into the geometric model; and traversing the particle along the particle track from one uniform volume element to another uniform volume element in integer based increments (Fig. 2; Fig 3; CL1, L66

to CL2, L11; CL2, L34-57), because in medical imaging and 3-D image processing the data is already available in volume element (voxel) based form (CL2, L34-37); and as an alternative to 3-D geometrical model based systems, several 3-D voxel based systems have been developed; in these the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer; alternatively, digitization is performed by scan converting a 3-D geometric model (CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Kaufman et al.** that included arranging a plurality of substantially uniform volume elements into the geometric model; and traversing the particle along the particle track from one uniform volume element to another uniform volume element in integer based increments. The artisan would have been motivated because in medical imaging and 3-D image processing the data was already available in volume element (voxel) based form; and as an alternative to 3-D geometrical model based systems, several 3-D voxel based systems had been developed; in these the 3-D object was discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer; alternatively, digitization was performed by scan converting a 3-D geometric model.

Per claim 9: **Silver** teaches the step of setting an initial condition for the particle track (CL13, L3-6).

16. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Fox et al.** (U.S. Patent 6,083,167).

16.1 As per claim 2, **Silver** and **Kaufman et al.** teach the method of claim 1. **Silver** does not expressly teach the step of converting a plurality of pixels of information contained in a medical image into the uniform volume elements. **Fox et al.** teaches the step of converting a plurality of pixels of information contained in a medical image into a three dimensional image of the treatment volume (CL5, L41-45), because that would allow the treatment planner to overlay the dose upon the treatment volume and display this information to the medical personnel (CL5, L49-52). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Fox et al.** that included the step of converting a plurality of pixels of information contained in a medical image into a three dimensional image of the treatment volume. The artisan would have been motivated because that would allow the treatment planner to overlay the dose upon the treatment volume and display this information to the medical personnel.

Kaufman et al. teaches the step of converting a three dimensional image of the treatment volume into the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57), because with voxel based representation, for every small modification, there is no need of repeatedly scan converting and manipulating the graphical display lists as required in 3-D geometrical model based systems (CL2, L65 to CL3, L6). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with

the method of **Kaufman et al.** that included the step of converting a three dimensional image of the treatment volume into the uniform volume elements. The artisan would have been motivated because with voxel based representation, for every small modification, there would be no need of repeatedly scan converting and manipulating the graphical display lists as required in 3-D geometrical model based systems.

17. Claims 3 and 4 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Coniglione et al.** (U.S. Patent 6,589,502).

17.1 As per claims 3 and 4, **Silver** and **Kaufman et al.** teach the method of claim 1. **Silver** does not expressly teach the step of defining a material to be associated with each uniform volume element; and the step of mapping each the material to an array. **Coniglione et al.** teaches the step of defining a material to be associated with the treatment volume (CL1, L7-9; CL 4, L39-44), because the selected material would determine the desired amount of radiation emitted by the material when it is used in a patient (CL 4, L43-44). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Coniglione et al.** that included the step of defining a material to be associated with the treatment volume. The artisan would have been motivated because the selected material would determine the desired amount of radiation emitted by the material when it is used in a patient.

Kaufman et al. teaches the step of converting a three dimensional image of the treatment volume into the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57); and the step of defining a material to be associated with each uniform volume element; and the step of mapping each the material to an array, because the 3-D array of voxels in the cubic frame buffer can be loaded with the data related to the volume elements (CL2, L49-50). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to combine the method of **Silver** with the method of **Coniglione et al.** that included the step of defining a material to be associated with the treatment volume and the method of **Kaufman et al.** that included the step of converting a three dimensional image of the treatment volume into the uniform volume elements; and the step of defining a material to be associated with each uniform volume element; and the step of mapping each the material to an array. The artisan would have been motivated because the 3-D array of voxels in the cubic frame buffer could be loaded with the data related to the volume elements.

18. Claims 5, 13-16, 20-23 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Coniglione et al.** (U.S. Patent 6,589,502) and **Tumer** (U.S. Patent 5,821,541).

18.1 As per claim 5, **Silver** and **Kaufman et al.** teach the method of claim 1. **Silver** does not expressly teach determining a material of both the one and the another uniform volume elements. **Coniglione et al.** teaches the step of defining a material to be associated with the treatment volume (CL1, L7-9; CL 4, L39-44), because the selected material would determine the desired

amount of radiation emitted by the material when it is used in a patient (CL 4, L43-44). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Coniglione et al.** that included the step of defining a material to be associated with the treatment volume. The artisan would have been motivated because the selected material would determine the desired amount of radiation emitted by the material when it is used in a patient.

Kaufman et al. teaches the step of converting a three dimensional image of the treatment volume into the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57); and determining a material of both the one and the another uniform volume elements, because the 3-D array of voxels in the cubic frame buffer can be loaded with the data related to the volume elements (CL2, L49-50). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to combine the method of **Silver** with the method of **Coniglione et al.** that included the step of defining a material to be associated with the treatment volume and the method of **Kaufman et al.** that included the step of converting a three dimensional image of the treatment volume into the uniform volume elements; and determining a material of both the one and the another uniform volume elements. The artisan would have been motivated because the 3-D array of voxels in the cubic frame buffer could be loaded with the data related to the volume elements.

Silver does not expressly teach terminating the step of traversing the particle when the material of another uniform volume element is substantially different from the material of the one uniform volume element. **Tumer** teaches terminating the step of traversing the particle when the material of another uniform volume element is substantially different from the material

of the one uniform volume element (CL6, L1-4; CL 6, L6-14), because that allows detecting and imaging of the radiation produced by the particles and detecting where the ray of particles is stopped (CL 2, L24-27; CL6, L9-10). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Tumer** that included terminating the step of traversing the particle when the material of another uniform volume element is substantially different from the material of the one uniform volume element.. The artisan would have been motivated because that would allow detecting and imaging of the radiation produced by the particles and detecting where the ray of particles was stopped.

18.2 As per claim 13, **Silver** teaches a method for simulating particle transport through a geometric model (CL12, L38-48; CL13, L3-17).

Silver does not expressly teach arranging a plurality of substantially uniform volume elements into the geometric model. **Kaufman et al.** teaches arranging a plurality of substantially uniform volume elements into the geometric model (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57), because in medical imaging and 3-D image processing the data is already available in volume element (voxel) based form (CL2, L34-37); and as an alternative to 3-D geometrical model based systems, several 3-D voxel based systems have been developed; in these the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer; alternatively, digitization is performed by scan converting a 3-D

geometric model (CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Kaufman et al.** that included arranging a plurality of substantially uniform volume elements into the geometric model. The artisan would have been motivated because in medical imaging and 3-D image processing the data was already available in volume element (voxel) based form; and as an alternative to 3-D geometrical model based systems, several 3-D voxel based systems had been developed; in these the 3-D object was discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer; alternatively, digitization was performed by scan converting a 3-D geometric model.

Silver does not expressly teach defining a material to be associated with each uniform volume element. **Coniglione et al.** teaches the step of defining a material to be associated with the treatment volume (CL1, L7-9; CL 4, L39-44), because the selected material would determine the desired amount of radiation emitted by the material when it is used in a patient (CL 4, L43-44). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Coniglione et al.** that included the step of defining a material to be associated with the treatment volume. The artisan would have been motivated because the selected material would determine the desired amount of radiation emitted by the material when it is used in a patient.

Silver does not expressly teach at least one of the uniform volume elements corresponding to a radiation source. **Coniglione et al.** teaches at least one of the uniform volume elements corresponding to a radiation source (CL1, L26-27; CL 10, L13-17), because the

radiation therapy is implemented by placing a radiation source near or within the tissue to be treated (CL1, L26-27). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Coniglione et al.** that included at least one of the uniform volume elements corresponding to a radiation source. The artisan would have been motivated because the radiation therapy would be implemented by placing a radiation source near or within the tissue to be treated.

Silver does not expressly teach describing a particle track with a primary direction of movement through the geometric model. **Tumer** teaches describing a particle track with a primary direction of movement through the geometric model (CL 6, L6-14), because that allows detecting and imaging of the radiation produced by the particles and detecting the direction of the particle by following the track (CL 2, L24-27; CL6, 12-14). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Tumer** that included describing a particle track with a primary direction of movement through the geometric model. The artisan would have been motivated because that would allow detecting and imaging of the radiation produced by the particles and detecting the direction of the particle by following the track.

Silver does not expressly teach the particle track beginning substantially internally within the geometric model in a starting element. **Tumer** teaches the particle track beginning substantially internally within the geometric model in a starting element (CL 22, L45-49), because that allows determining the energy lost by the particles in traversing from the starting element to the ending element (CL 22, L45-49). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the

method of **Tumer** that included the particle track beginning substantially internally within the geometric model in a starting element. The artisan would have been motivated because that would allow determining the energy lost by the particles in traversing from the starting element to the ending element.

Silver does not expressly teach particle track beginning in a starting element of the uniform volume elements and traversing to a next element of the uniform volume elements. **Kaufman et al.** teaches particle track beginning in a starting element of the uniform volume elements and traversing to a next element of the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57), because in medical imaging and 3-D image the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer (CL2, L34-37; CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Kaufman et al.** that included particle track beginning in a starting element of the uniform volume elements and traversing to a next element of the uniform volume elements. The artisan would have been motivated because in medical imaging and 3-D image processing the 3-D object was discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer.

Silver does not expressly teach following a particle along the particle track through the geometric model until the material of the next element is substantially different from the material of the starting element. **Tumer** teaches following a particle along the particle track through the

geometric model until the material of the next element is substantially different from the material of the starting element (CL6, L1-4; CL 6, L6-14), because that allows detecting and imaging of the radiation produced by the particles and detecting where the ray of particles is stopped (CL 2, L24-27; CL6, L9-10). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Tumer** that included following a particle along the particle track through the geometric model until the material of the next element is substantially different from the material of the starting element. The artisan would have been motivated because that would allow detecting and imaging of the radiation produced by the particles and detecting where the ray of particles was stopped.

Per claim 14: **Silver** teaches the step of describing the particle track comprises the steps of defining an initial position and a vector for the particle (CL13, L3-6).

18.3 As per claim 15, **Silver, Kaufman et al., Coniglione et al.** and **Tumer** teach the method of claim 13. **Silver** does not expressly teach the step of defining a material to be associated with each uniform volume element further comprises the step of mapping each the material to an array. **Coniglione et al.** teaches the step of defining a material to be associated with the treatment volume (CL1, L7-9; CL 4, L39-44), because the selected material would determine the desired amount of radiation emitted by the material when it is used in a patient (CL 4, L43-44). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Coniglione et al.** that included the step of defining a material to be associated with the treatment volume. The artisan would have been

motivated because the selected material would determine the desired amount of radiation emitted by the material when it is used in a patient.

Kaufman et al. teaches the step of converting a three dimensional image of the treatment volume into the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57); and the step of defining a material to be associated with each uniform volume element further comprises the step of mapping each the material to an array, because the 3-D array of voxels in the cubic frame buffer can be loaded with the data related to the volume elements (CL2, L49-50). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to combine the method of **Silver** with the method of **Coniglione et al.** that included the step of defining a material to be associated with the treatment volume and the method of **Kaufman et al.** that included the step of converting a three dimensional image of the treatment volume into the uniform volume elements; and the step of defining a material to be associated with each uniform volume element further comprising the step of mapping each the material to an array. The artisan would have been motivated because the 3-D array of voxels in the cubic frame buffer could be loaded with the data related to the volume elements.

18.4 As per claim 16, **Silver, Kaufman et al., Coniglione et al.** and **Tumer** teach the method of claim 13. **Silver** does not expressly teach that the step of following the particle along the particle track comprises the step of stepping along the particle track in integer based increments of the coordinate system. **Kaufman et al.** teaches that the step of following the particle along the particle track comprises the step of stepping along the particle track in integer based increments of the coordinate system (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57),

because in medical imaging and 3-D image processing the data is already available in volume element (voxel) based form (CL2, L34-37); in these the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer (CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Kaufman et al.** that included the step of following the particle along the particle track comprising the step of stepping along the particle track in integer based increments of the coordinate system. The artisan would have been motivated because in medical imaging and 3-D image processing the data was already available in volume element (voxel) based form; in these the 3-D object was discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer.

Silver does not expressly teach the step of following the particle along the particle track comprises the step of stepping along the particle track along the primary direction of a movement. **Tumer** teaches the step of following the particle along the particle track comprises the step of stepping along the particle track along the primary direction of a movement (CL 6, L6-14), because that allows detecting and imaging of the radiation produced by the particles and detecting the direction of the particle by following the track (CL 2, L24-27; CL6, 12-14). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Tumer** that included the step of following the particle along the particle track comprising the step of stepping along the particle track along the primary direction of a movement l. The artisan would have been motivated because that would

allow detecting and imaging of the radiation produced by the particles and detecting the direction of the particle by following the track.

18.5 As per claim 20, **Silver** teaches a computer readable medium having computer executable instructions for tracking a movement of a particle through a geometric model (Fig 3; CL9, L40-42; CL9, L57-60; CL12, L38-48; CL13, L3-17); the computer executable instructions for performing the steps of:

projecting the movement of the particle through the geometric model with a particle track (CL13, L3-17).

Silver does not expressly teach arranging a plurality of substantially uniform volume elements into the geometric model. **Kaufman et al.** teaches arranging a plurality of substantially uniform volume elements into the geometric model (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivations for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 18.2 above.

Silver does not expressly teach mapping a material associated with each the uniform volume element to an array. **Coniglione et al.** teaches mapping a material associated with each the uniform volume element to an array (CL1, L7-9; CL 4, L39-44). The motivations for combining the method of **Silver** with the method of **Coniglione et al.** is presented in paragraph 17.1 above.

Silver does not expressly teach at least one of the uniform volume elements being mapped to a radiation source. **Coniglione et al.** teaches at least one of the uniform volume

elements being mapped to a radiation source (CL1, L26-27; CL 10, L13-17). The motivations for combining the method of **Silver** with the method of **Coniglione et al.** is presented in paragraph 18.2 above.

Silver does not expressly teach particle track beginning in a starting element of the uniform volume elements and traversing to a next element of the uniform volume elements. **Kaufman et al.** teaches particle track beginning in a starting element of the uniform volume elements and traversing to a next element of the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivations for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 18.2 above.

Silver does not expressly teach traversing the particle along the particle track in integer based increments. **Kaufman et al.** teaches traversing the particle along the particle track in integer based increments (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivations for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 15.1 above.

Silver does not expressly teach traversing the particle along the particle track until the material of the next element is substantially different from the material of the starting element. **Tumer** teaches traversing the particle along the particle track until the material of the next element is substantially different from the material of the starting element (CL6, L1-4; CL 6, L6-14). The motivations for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 18.2 above.

18.6 As per claim 21, **Silver, Kaufman et al., Coniglione et al.** and **Tumer** teach the computer readable medium of claim 20. **Silver** teaches computer executable instructions for performing the step of storing the array in a storage device (Fig 3; CL9, L40-42; CL9, L57-60).

18.7 As per claims 22 and 23, **Silver, Kaufman et al., Coniglione et al.** and **Tumer** teach the computer readable medium of claim 20. **Silver** does not expressly teach computer executable instructions for performing the step of establishing a center value for the particle track along a primary direction of movement; and computer executable instructions for performing the step of storing the array by integers determined from a selected coordinate system. **Kaufman et al.** teaches the computer executable instructions for performing the step of establishing a center value for the particle track along a primary direction of movement; and computer executable instructions for performing the step of storing the array by integers determined from a selected coordinate system (CL3, L65-68; CL7, L40-43), because in medical imaging and 3-D image the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer (CL2, L34-37; CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Kaufman et al.** that included computer executable instructions for performing the step of establishing a center value for the particle track along a primary direction of movement; and computer executable instructions for performing the step of storing the array by integers determined from a selected coordinate system. The artisan would have been motivated because in medical imaging and 3-D image processing the 3-D object was discretized, sampled and

stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer.

Per claim 28: **Silver** teaches computer executable instructions for performing the step of displaying the geometric model (CL1, L32-35; CL1, L40-42; CL3, L40-42).

19. Claims 6 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Coniglione et al.** (U.S. Patent 6,589,502), **Tumer** (U.S. Patent 5,821,541) and **Schoolman** (U.S. Patent 5,493,595).

19.1 As per claims 6 and 7, **Silver, Kaufman et al. , Coniglione et al.** and **Tumer** teach the method of claim 5. **Silver** does not expressly teach the step of determining a position of intersection along the particle track where the material of the one uniform volume element changed into the material of another uniform volume element; and the step of reporting the position of intersection. **Schoolman** teaches the step of determining a position of intersection along the particle track where the material of the one uniform volume element changed into the material of the another uniform volume element; and the step of reporting the position of intersection (CL2, L60-63), because the information associated with each voxel is a measure of the concentration of radioactive material at the corresponding volume increment (CL 2, L35-37). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Schoolman** that included the step of

determining a position of intersection along the particle track where the material of the one uniform volume element changed into the material of the another uniform volume element; and the step of reporting the position of intersection. The artisan would have been motivated because the information associated with each voxel would be a measure of the concentration of radioactive material at the corresponding volume increment.

20. Claims 8 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Tumer** (U.S. Patent 5,821,541).

20.1 As per claim 8, **Silver and Kaufman et al.** teach the method of claim 1. **Silver** does not expressly teach that the particle track has a primary direction of movement, further comprising the step of traversing the particle along the particle track along the primary direction of movement. **Tumer** teaches that the particle track has a primary direction of movement, further comprising the step of traversing the particle along the particle track along the primary direction of movement (CL 6, L6-14), because that allows detecting and imaging of the radiation produced by the particles and detecting the direction of the particle by following the track (CL 2, L24-27; CL6, 12-14). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Tumer** that included that the particle track having a primary direction of movement, further comprising the step of traversing the particle along the particle track along the primary direction of movement. The artisan would have been motivated because that would allow detecting and imaging of the

radiation produced by the particles and detecting the direction of the particle by following the track.

20.2 As per claim 10, **Silver and Kaufman et al.** teach the method of claim 9. **Silver** does not expressly teach that the particle traverses along the particle track beginning in a starting element. **Tumer** teaches that the particle traverses along the particle track beginning in a starting element (CL 22, L45-49), because that allows determining the energy lost by the particles in traversing from the starting element to the ending element (CL 22, L45-49). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Tumer** that included the particle traversing along the particle track beginning in a starting element. The artisan would have been motivated because that would allow determining the energy lost by the particles in traversing from the starting element to the ending element.

Silver does not expressly teach particle track beginning in a starting element of the uniform volume elements and going to a next element of the uniform volume elements. **Kaufman et al.** teaches particle track beginning in a starting element of the uniform volume elements and going to a next element of the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57), because in medical imaging and 3-D image the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer (CL2, L34-37; CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of

Kaufman et al. that included particle track beginning in a starting element of the uniform volume elements and going to a next element of the uniform volume elements. The artisan would have been motivated because in medical imaging and 3-D image processing the 3-D object was discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer.

Silver does not expressly teach the step of determining a center value of the starting element along a primary direction of movement for the particle track, the center value representing at least a portion of an adjusted coordinate from which the particle will begin traversal along the particle track. **Kaufman et al.** teaches the step of determining a center value of the starting element along a primary direction of movement for the particle track, the center value representing at least a portion of an adjusted coordinate from which the particle will begin traversal along the particle track (CL3, L65-68; CL7, L40-43), because in medical imaging and 3-D image the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer (CL2, L34-37; CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Kaufman et al.** that included the step of determining a center value of the starting element along a primary direction of movement for the particle track, the center value representing at least a portion of an adjusted coordinate from which the particle will begin traversal along the particle track. The artisan would have been motivated because in medical imaging and 3-D image processing the 3-D object was discretized, sampled and stored in large 3-

D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer.

21. Claims 17, 19 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Fox et al.** (U.S. Patent 6,083,167), **Coniglione et al.** (U.S. Patent 6,589,502), **Tumer** (U.S. Patent 5,821,541) and **Moscovitch** (U.S. Patent 5,498,876).

21.1 As per claim 17, **Silver** teaches describing a plurality of particle tracks through the geometric model; and simulating a particle movement along each the particle track through the geometric model (CL12, L38-48; CL13, L3-17); and

the particle corresponding to an alpha emission emanating from the radiation source during the radiation therapy (CL9, L26-27).

Silver does not expressly teach a method of computationally enlarging a radiation distribution for a treatment volume irradiated during radiation therapy; and computing a distribution of radiation doses based upon the particle movement along each the particle track. **Moscovitch** teaches a method of computationally enlarging a radiation distribution for a treatment volume irradiated during radiation therapy; and computing a distribution of radiation doses based upon the particle movement along each the particle track (CL3, L59 to CL 4, L4; CL8, L63-67; CL7, L29-39), because that allows mapping the radiation distribution in a three dimensional structure and calculating the absorbed dose and radiation energy (CL8, L65-67;

CL8, L46-48). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Moscovitch** that included a method of computationally enlarging a radiation distribution for a treatment volume irradiated during radiation therapy; and computing a distribution of radiation doses based upon the particle movement along each the particle track. The artisan would have been motivated because that would allow mapping the radiation distribution in a three dimensional structure and calculating the absorbed dose and radiation energy.

Silver does not expressly teach having a radiation source substantially internal within a patient. **Coniglione et al.** teaches having a radiation source substantially internal within a patient (CL1, L26-27; CL 10, L13-17), because the radiation therapy is implemented by placing a radiation source near or within the tissue to be treated (CL1, L26-27). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Coniglione et al.** that included having a radiation source substantially internal within a patient. The artisan would have been motivated because the radiation therapy would be implemented by placing a radiation source near or within the tissue to be treated.

Silver does not expressly teach obtaining a medical image of the treatment volume, the medical image containing a plurality of pixels of information. **Fox et al.** teaches obtaining a medical image of the treatment volume, the medical image containing a plurality of pixels of information (CL5, L41-45), because that would allow the treatment planner to overlay the dose upon the treatment volume and display this information to the medical personnel (CL5, L49-52). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention

to modify the method of **Silver** with the method of **Fox et al.** that included obtaining a medical image of the treatment volume, the medical image containing a plurality of pixels of information. The artisan would have been motivated because that would allow the treatment planner to overlay the dose upon the treatment volume and display this information to the medical personnel.

Silver does not expressly teach converting the pixels into a plurality of substantially uniform volume elements; and arranging the uniform volume elements into a geometric model. **Kaufman et al.** teaches converting the pixels into a plurality of substantially uniform volume elements; and arranging the uniform volume elements into a geometric model (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57), because in medical imaging and 3-D image processing the data is already available in volume element (voxel) based form (CL2, L34-37); and as an alternative to 3-D geometrical model based systems, several 3-D voxel based systems have been developed; in these the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer; alternatively, digitization is performed by scan converting a 3-D geometric model (CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Kaufman et al.** that included converting the pixels into a plurality of substantially uniform volume elements; and arranging the uniform volume elements into a geometric model. The artisan would have been motivated because in medical imaging and 3-D image processing the data was already available in volume element (voxel) based form; and as an alternative to 3-D geometrical model based systems, several 3-D voxel based systems had been developed; in

these the 3-D object was discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer; alternatively, digitization was performed by scan converting a 3-D geometric model.

Silver does not expressly teach defining a material to be associated with each uniform volume element. **Coniglione et al.** teaches the step of defining a material to be associated with the treatment volume (CL1, L7-9; CL 4, L39-44), because the selected material would determine the desired amount of radiation emitted by the material when it is used in a patient (CL 4, L43-44). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Coniglione et al.** that included the step of defining a material to be associated with the treatment volume. The artisan would have been motivated because the selected material would determine the desired amount of radiation emitted by the material when it is used in a patient.

Silver does not expressly teach the particle track beginning substantially internally within the geometric model in a starting element. **Tumer** teaches the particle track beginning substantially internally within the geometric model in a starting element (CL 22, L45-49), because that allows determining the energy lost by the particles in traversing from the starting element to the ending element (CL 22, L45-49). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Tumer** that included the particle track beginning substantially internally within the geometric model in a starting element. The artisan would have been motivated because that

would allow determining the energy lost by the particles in traversing from the starting element to the ending element.

Silver does not expressly teach the particle tracks beginning at one of the uniform volume elements corresponding to a radiation source. **Coniglione et al.** teaches the particle tracks beginning at one of the uniform volume elements corresponding to a radiation source (CL1, L26-27; CL 10, L13-17), because the radiation therapy is implemented by placing a radiation source near or within the tissue to be treated (CL1, L26-27). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Coniglione et al.** that included the particle tracks beginning at one of the uniform volume elements corresponding to a radiation source. The artisan would have been motivated because the radiation therapy would be implemented by placing a radiation source near or within the tissue to be treated.

Silver does not expressly teach the particle tracks having a primary direction of movement. **Tumer** teaches the particle tracks having a primary direction of movement (CL 6, L6-14), because that allows detecting and imaging of the radiation produced by the particles and detecting the direction of the particle by following the track (CL 2, L24-27; CL6, 12-14). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Tumer** that included the particle tracks having a primary direction of movement. The artisan would have been motivated because that would allow detecting and imaging of the radiation produced by the particles and detecting the direction of the particle by following the track.

Silver does not expressly teach particle track beginning in a starting element of the uniform volume elements and traversing to a next element of the uniform volume elements; and simulating a particle movement along each the particle track through the geometric model in integer based increments. **Kaufman et al.** teaches particle track beginning in a starting element of the uniform volume elements and traversing to a next element of the uniform volume elements; and simulating a particle movement along each the particle track through the geometric model in integer based increments (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57), because in medical imaging and 3-D image the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer (CL2, L34-37; CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Kaufman et al.** that included particle track beginning in a starting element of the uniform volume elements and traversing to a next element of the uniform volume elements; and simulating a particle movement along each the particle track through the geometric model in integer based increments. The artisan would have been motivated because in medical imaging and 3-D image processing the 3-D object was discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer.

Silver does not expressly teach simulating a particle movement until a position when the material of the next element is substantially different from the material of the starting element; the position corresponding to at least one of the particle being captured, scattered and exited

from the geometric model. **Tumer** teaches simulating a particle movement until a position when the material of the next element is substantially different from the material of the starting element; the position corresponding to at least one of the particle being captured, scattered and exited from the geometric model (CL6, L1-4; CL 6, L6-14), because that allows detecting and imaging of the radiation produced by the particles and detecting where the ray of particles is stopped (CL 2, L24-27; CL6, L9-10). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Tumer** that included simulating a particle movement until a position when the material of the next element is substantially different from the material of the starting element; the position corresponding to at least one of the particle being captured, scattered and exited from the geometric model. The artisan would have been motivated because that would allow detecting and imaging of the radiation produced by the particles and detecting where the ray of particles was stopped.

Silver does not expressly teach the particle corresponding to a beta or gamma emission emanating from the radiation source during the radiation therapy. **Coniglione et al.** teaches the particle corresponding to a beta or gamma emission emanating from the radiation source during the radiation therapy (CL1, L47-56), because it is often preferred to use radiation sources which emit low energy radiation (CL1, L55-56). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Coniglione et al.** that included the particle corresponding to a beta or gamma emission emanating from the radiation source during the radiation therapy. The artisan would have been

motivated because it would be often preferred to use radiation sources which emit low energy radiation.

21.2 As per claim 19, **Silver, Kaufman et al., Fox et al., Coniglione et al., Tumer** and **Moscovitch** teach the method of claim 17. **Silver** does not expressly teach the step of converting the pixels into the uniform volume elements further comprises the step of proportionally converting a volume and shape of the pixels into a corresponding volume and shape of the uniform volume elements. **Kaufman et al.** teaches the step of converting the pixels into the uniform volume elements further comprises the step of proportionally converting a volume and shape of the pixels into a corresponding volume and shape of the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57), because in medical imaging and 3-D image processing the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer (CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Kaufman et al.** that included the step of converting the pixels into the uniform volume elements further comprising the step of proportionally converting a volume and shape of the pixels into a corresponding volume and shape of the uniform volume elements. The artisan would have been motivated because in medical imaging and 3-D image processing the 3-D object was discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer.

21.3 As per Claim 29, it is rejected based on the same reasoning as Claim 17, supra. Claim 29 is computer readable medium claim reciting the same limitations as Claim 17, as taught throughout by **Silver, Kaufman et al., Fox et al., Coniglione et al., Tumer** and **Moscovitch.**

22. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Fox et al.** (U.S. Patent 6,083,167), **Coniglione et al.** (U.S. Patent 6,589,502), **Tumer** (U.S. Patent 5,821,541), **Moscovitch** (U.S. Patent 5,498,876) and **Schoolman** (U.S. Patent 5,493,595).

22.1 As per claim 18, **Silver, Kaufman et al., Fox et al., Coniglione et al., Tumer** and **Moscovitch** teach the method of claim 17. **Silver** does not expressly teach the step of generating a plurality of axial slices of the treatment volume. **Schoolman** teaches the step of generating a plurality of axial slices of the treatment volume (CL9, L64-66), because that allows generating image data of the treatment volume for processing by the stereoscopic three dimensional medical imaging system(CL 9, L40-42). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the method of **Silver** with the method of **Schoolman** that included the step of generating a plurality of axial slices of the treatment volume. The artisan would have been motivated because that would allow generating image data of the treatment volume for processing by the stereoscopic three dimensional medical imaging system.

23. Claims 25 and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Fox et al.** (U.S. Patent 6,083,167), **Coniglione et al.** (U.S. Patent 6,589,502) and **Tumer** (U.S. Patent 5,821,541).

23.1 As per claim 25, **Silver, Kaufman et al., Coniglione et al.** and **Tumer** teach the computer readable medium of claim 20.

Silver does not expressly teach computer executable instructions for performing the steps of reading a medical image of a treatment volume irradiated by the radiation source having a plurality of pixels of information. **Fox et al.** teaches computer executable instructions for performing the steps of reading a medical image of a treatment volume irradiated by the radiation source having a plurality of pixels of information (CL5, L41-45). The motivations for combining the method of **Silver** with the method of **Fox et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach converting the pixels into uniform volume elements. **Kaufman et al.** teaches converting the pixels into a plurality of substantially uniform volume elements; and arranging the uniform volume elements into a geometric model (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivations for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 21.1 above.

23.2 As per claim 25, **Silver, Kaufman et al., Coniglione et al., Fox et al.** and **Tumer** teach the computer readable medium of claim 25. **Silver** does not expressly teach computer

executable instructions for performing the step of proportionally converting a volume and shape of the pixels into a corresponding volume and shape of the uniform a volume elements. **Kaufman et al.** teaches computer executable instructions for performing the step of proportionally converting a volume and shape of the pixels into a corresponding volume and shape of the uniform a volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivations for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 21.2 above.

24. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Fox et al.** (U.S. Patent 6,083,167), **Coniglione et al.** (U.S. Patent 6,589,502), **Tumer** (U.S. Patent 5,821,541), and **Schoolman** (U.S. Patent 5,493,595).

24.1 As per claim 27, **Silver, Kaufman et al., Coniglione et al., Fox et al.** and **Tumer** teach the computer readable medium of claim 25. **Silver** does not expressly teach the medical image comprises a plurality of substantially cross-sectional slices of the treatment volume. **Schoolman** teaches the medical image comprises a plurality of substantially cross-sectional slices of the treatment volume (CL9, L64-66), because that allows generating image data of the treatment volume for processing by the stereoscopic three dimensional medical imaging system(CL 9, L40-42). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the computer readable medium of **Silver** with the computer readable medium of **Schoolman** that included the medical image comprising a plurality of substantially

cross-sectional slices of the treatment volume. The artisan would have been motivated because that would allow generating image data of the treatment volume for processing by the stereoscopic three dimensional medical imaging system.

Silver does not expressly teach computer executable instructions for performing the step of stacking the uniform volume elements into a three dimensional representation of the treatment volume. **Kaufman et al.** teaches computer executable instructions for performing the step of stacking the uniform volume elements into a three dimensional representation of the treatment volume (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57), because in medical imaging and 3-D image processing the 3-D object is discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values is obtained and stored in the cubic frame buffer (CL2, L39-53). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the computer readable medium of **Silver** with the computer readable medium of **Kaufman et al.** that included computer executable instructions for performing the step of stacking the uniform volume elements into a three dimensional representation of the treatment volume. The artisan would have been motivated because in medical imaging and 3-D image processing the 3-D object was discretized, sampled and stored in large 3-D cubic frame buffer memory comprising unit cubic cells; a regularly spaced 3-D matrix array of values was obtained and stored in the cubic frame buffer.

25. Claim 30 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Fox**

et al. (U.S. Patent 6,083,167), **Coniglione et al.** (U.S. Patent 6,589,502), and **Mackie et al.** (U.S. Patent 6,345,114).

25.1 As per claim 30, **Silver** teaches a computer readable medium having computer executable modules, comprising a projection module for tracking a movement of a particle through the geometric representation (Fig 3; CL9, L40-42; CL9, L57-60; CL12, L38-48; CL13, L3-17).

Silver does not expressly teach modules for enlarging a radiation distribution of a treatment volume irradiated during a radiation therapy. **Moscovitch** teaches modules for enlarging a radiation distribution of a treatment volume irradiated during a radiation therapy (CL3, L59 to CL 4, L4; CL8, L63-67; CL7, L29-39). The motivation for combining the computer readable medium of **Silver** with the computer readable medium of **Moscovitch** is presented in paragraph 21.1 above.

Silver does not expressly teach having a radiation source. **Coniglione et al.** teaches having a radiation source (CL1, L26-27; CL 10, L13-17). The motivation for combining the computer readable medium of **Silver** with the computer readable medium of **Coniglione et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach a reader module for converting a plurality of pixels of information contained in a medical image into a corresponding plurality of uniform volume elements; a modeling module for arranging the uniform volume elements into a geometric representation of the treatment volume; and tracking a movement of a particle through the geometric representation according to integer based steps. **Kaufman et al.** teaches a reader

module for converting a plurality of pixels of information contained in a medical image into a corresponding plurality of uniform volume elements; a modeling module for arranging the uniform volume elements into a geometric representation of the treatment volume; and tracking a movement of a particle through the geometric representation according to integer based steps (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivation for combining the computer readable medium of **Silver** with the computer readable medium of **Kaufman et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach a storage module for storing a material for each the uniform volume elements, at least one of the uniform volume elements being stored as corresponding to the radiation source. **Coniglione et al.** teaches a storage module for storing a material for each the uniform volume elements, at least one of the uniform volume elements being stored as corresponding to the radiation source (CL1, L7-9; CL 4, L39-44). The motivation for combining the computer readable medium of **Silver** with the computer readable medium of **Coniglione et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach a random generation module for calculating a status of the particle as the movement of the particle is tracked through the geometric representation. **Mackie et al.** teaches a random generation module for calculating a status of the particle as the movement of the particle is tracked through the geometric representation (CL9, L31-47), because that allows tracking randomly distributed particles with the probability of interaction with surrounding material (CL9, L34-41). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the computer readable medium of **Silver** with the computer readable medium of **Mackie et al.** that included a random generation module for

calculating a status of the particle as the movement of the particle is tracked through the geometric representation. The artisan would have been motivated because that would allow tracking randomly distributed particles with the probability of interaction with surrounding material.

26. Claims 31-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Coniglione et al.** (U.S. Patent 6,589,502), **Tumer** (U.S. Patent 5,821,541) and **Moscovitch** (U.S. Patent 5,498,876).

26.1 As per claim 31, **Silver** teaches creating a geometric model of the treatment volume; describing a movement having a primary direction thereof of a particle through the geometric model (CL12, L38-48; CL13, L3-17); and

the particle representing an alpha emission emanating from the radiation source during the radiation therapy (CL9, L26-27).

Silver does not expressly teach a method of enlarging a radiation distribution for a treatment volume irradiated during radiation therapy; and computing a distribution of radiation doses based upon the particle movement of the particle. **Moscovitch** teaches a method of enlarging a radiation distribution for a treatment volume irradiated during radiation therapy; and computing a distribution of radiation doses based upon the particle movement of the particle (CL3, L59 to CL 4, L4; CL8, L63-67; CL7, L29-39). The motivation for combining the

computer readable medium of **Silver** with the computer readable medium of **Moscovitch** is presented in paragraph 21.1 above.

Silver does not expressly teach describing a movement of a particle through the geometric model in integer based increments. **Kaufman et al.** teaches describing a movement of a particle through the geometric model in integer based increments (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivation for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach describing a movement having a primary direction of a particle through the geometric model along the primary direction. **Tumer** teaches describing a movement having a primary direction of a particle through the geometric model along the primary direction (CL 6, L6-14). The motivation for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 21.1 above.

Silver does not expressly teach the particle representing a beta or gamma emission emanating from the radiation source during the radiation therapy. **Coniglione et al.** teaches the particle representing a beta or gamma emission emanating from the radiation source during the radiation therapy (CL1, L47-56). The motivation for combining the method of **Silver** with the method of **Coniglione et al.** is presented in paragraph 21.1 above.

26.2 As per claim 32, **Silver, Kaufman et al., Coniglione et al., Tumer** and **Moscovitch** teach the method of claim 31.

Silver does not expressly teach that the geometric model is comprised of a plurality of substantially uniform volume elements. **Kaufman et al.** teaches that the geometric model is comprised of a plurality of substantially uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivation for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach the step of defining a material to be associated with each the uniform volume element. **Coniglione et al.** teaches the step of defining a material to be associated with the treatment volume (CL1, L7-9; CL 4, L39-44). **Silver** does not expressly teach at least one of the uniform volume elements corresponding to the radiation source. **Coniglione et al.** teaches at least one of the uniform volume elements corresponding to the radiation source (CL1, L26-27; CL 10, L13-17). The motivation for combining the method of **Silver** with the method of **Coniglione et al.** is presented in paragraph 21.1 above.

26.3 As per claim 33, **Silver, Kaufman et al., Coniglione et al., Tumer** and **Moscovitch** teach the method of claim 32. **Silver** teaches the step of describing the movement of the particle through the geometric model (CL12, L38-48; CL13, L3-17).

Silver does not expressly teach that the movement begins substantially internally within the geometric model in a starting element. **Tumer** teaches that the movement begins substantially internally within the geometric model in a starting element particle track beginning substantially internally within the geometric model in a starting element (CL 22, L45-49), because that allows determining the energy lost by the particles in traversing from the starting

element to the ending element (CL 22, L45-49). The motivation for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 21.1 above.

Silver does not expressly teach the movement begins substantially internally in a starting element of the uniform volume elements and traverses to a next element of the uniform volume elements. **Kaufman et al.** teaches the movement begins substantially internally in a starting element of the uniform volume elements and traverses to a next element of the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivation for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach the movement traverses to a next element of the uniform volume elements until the material of the next element is substantially different from the material of the starting element. **Tumer** teaches the movement traverses to a next element of the uniform volume elements until the material of the next element is substantially different from the material of the starting element (CL6, L1-4; CL 6, L6-14). The motivation for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 21.1 above.

26.4 As per claim 34, **Silver, Kaufman et al., Coniglione et al., Tumer** and **Moscovitch** teach the method of claim 33. **Silver** does not expressly teach the step of determining a position where along the movement the next element is substantially different from the material of the starting element. **Tumer** teaches the step of determining a position where along the movement the next element is substantially different from the material of the starting element (CL6, L1-4; CL 6, L6-14). The motivation for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 21.1 above.

26.5 As per claim 35, **Silver, Kaufman et al., Coniglione et al., Tumer** and **Moscovitch** teach the method of claim 33. **Silver, Kaufman et al., Coniglione et al., Tumer** and **Moscovitch** also teach a computer readable medium having computer executable instructions for performing the steps as recited in claim 31, as presented in Paragraph 26.1 above.

27. Claims 36-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Coniglione et al.** (U.S. Patent 6,589,502), **Tumer** (U.S. Patent 5,821,541) and **Nelson et al.** (U.S. Patent 6,212,540).

27.1 As per claim 36, **Silver** teaches describing a method for simulating particle transport through a geometric model (CL12, L38-48; CL13, L3-17).

Silver does not expressly teach arranging a plurality of substantially uniform volume elements into the geometric model. **Kaufman et al.** teaches arranging a plurality of substantially uniform volume elements into the geometric model (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivation for combining the computer readable medium of **Silver** with the computer readable medium of **Kaufman et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach defining a material to be associated with each the uniform volume element, at least one of the uniform volume elements corresponding to a radiation source. **Coniglione et al.** teaches defining a material to be associated with each the uniform

volume element, at least one of the uniform volume elements corresponding to a radiation source (CL1, L7-9; CL 4, L39-44). The motivation for combining the computer readable medium of **Silver** with the computer readable medium of **Coniglione et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach describing a particle track with a primary direction of movement through the geometric model. **Tumer** teaches describing a particle track with a primary direction of movement through the geometric model (CL 6, L6-14). The motivation for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 21.1 above.

Silver does not expressly teach following a particle along the particle track through the geometric model until the material of the next element is substantially different from the material of the starting element. **Tumer** teaches following a particle along the particle track through the geometric model until the material of the next element is substantially different from the material of the starting element (CL6, L1-4; CL 6, L6-14). The motivation for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 21.1 above.

Silver does not expressly teach the particle track beginning within that surface uniform volume element first encountered by a particle from an externally applied radiation source and to proceeding therefrom as if the particle track were born within the first surface uniform volume element. **Nelson et al.** teaches the particle track beginning within that surface uniform volume element first encountered by a particle from an externally applied radiation source and to proceeding therefrom as if the particle track were born within the first surface uniform volume element (CL6, L12-15), because the actions of the contrast material can be activated or

accelerated through the use of external radiation source (CL6, L12-15). It would have been obvious to one of ordinary skill in the art at the time of Applicants' invention to modify the computer readable medium of **Silver** with the computer readable medium of **Nelson et al.** that included the particle track beginning within that surface uniform volume element first encountered by a particle from an externally applied radiation source and to proceeding therefrom as if the particle track were born within the first surface uniform volume element. The artisan would have been motivated because the actions of the contrast material could be activated or accelerated through the use of external radiation source.

Per claim 37: **Silver** teaches the step of describing the particle track comprises the steps of defining an initial position and a vector for the particle (CL13, L3-6).

27.2 As per claim 38, **Silver, Kaufman et al., Coniglione et al., Tumer** and **Nelson et al.** teach the method of claim 36. **Silver** does not expressly teach the step of defining a material to be associated with each uniform volume element further comprises the step of mapping each the material to an array. **Coniglione et al.** teaches the step of defining a material to be associated with each uniform volume element further comprises the step of mapping each the material to an array (CL1, L7-9; CL 4, L39-44). **Kaufman et al.** teaches the step of converting a three dimensional image of the treatment volume into the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57); and the step of defining a material to be associated with each uniform volume element; and the step of mapping each the material to an array. The

motivations for combining the method of **Silver** with the method of **Coniglione et al.** and the method **Kaufman et al.** of are presented in paragraph 17.1 above.

27.3 As per claim 39, **Silver, Kaufman et al., Coniglione et al., Tumer** and **Nelson et al.** teach the method of claim 36. **Silver** does not expressly teach the step of following the particle along the particle track comprises the step of stepping along the particle track in integer based increments of the coordinate system. **Kaufman et al.** teaches the step of following the particle along the particle track comprises the step of stepping along the particle track in integer based increments of the coordinate system (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivation for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach the step of following the particle along the particle track along the primary direction of a movement. **Tumer** teaches the step of following the particle along the particle track along the primary direction of a movement (CL 6, L6-14). The motivation for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 21.1 above.

28. Claims 40 and 42 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Fox et al.** (U.S. Patent 6,083,167), **Coniglione et al.** (U.S. Patent 6,589,502), **Tumer** (U.S. Patent 5,821,541), **Moscovitch** (U.S. Patent 5,498,876) and **Nelson et al.** (U.S. Patent 6,212,540).

28.1 As per claim 40, **Silver** teaches describing a plurality of particle tracks through the geometric model; and simulating a particle movement along each the particle track through the geometric model (CL12, L38-48; CL13, L3-17); and

the particle corresponding to an alpha emission emanating from the radiation source during the radiation therapy (CL9, L26-27).

Silver does not expressly teach a method of computationally enlarging a radiation distribution for a treatment volume irradiated during radiation therapy; and computing a distribution of radiation doses based upon the particle movement along each the particle track. **Moscovitch** teaches a method of computationally enlarging a radiation distribution for a treatment volume irradiated during radiation therapy; and computing a distribution of radiation doses based upon the particle movement along each the particle track (CL3, L59 to CL 4, L4; CL8, L63-67; CL7, L29-39). The motivation for combining the method of **Silver** with the method of **Moscovitch** is presented in paragraph 21.1 above.

Silver does not expressly teach having a radiation source external to a patient; and the plurality of particle tracks beginning within that surface uniform volume element first encountered by particles from an externally-applied radiation source and proceeding therefrom as if the plurality of particle tracks were born within the first surface uniform volume element. **Nelson et al.** teaches having a radiation source external to a patient; and the plurality of particle tracks beginning within that surface uniform volume element first encountered by particles from an externally-applied radiation source and proceeding therefrom as if the plurality of particle

tracks were born within the first surface uniform volume element (CL6, L12-15). The motivation for combining the method of **Silver** with the method of **Nelson et al.** is presented in paragraph 27.1 above.

Silver does not expressly teach obtaining a medical image of the treatment volume, the medical image containing a plurality of pixels of information. **Fox et al.** teaches obtaining a medical image of the treatment volume, the medical image containing a plurality of pixels of information (CL5, L41-45). The motivation for combining the method of **Silver** with the method of **Fox et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach converting the pixels into a plurality of substantially uniform volume elements; and arranging the uniform volume elements into a geometric model. **Kaufman et al.** teaches converting the pixels into a plurality of substantially uniform volume elements; and arranging the uniform volume elements into a geometric model (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivation for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach defining a material to be associated with each uniform volume element. **Coniglione et al.** teaches the step of defining a material to be associated with the treatment volume (CL1, L7-9; CL 4, L39-44). The motivation for combining the method of **Silver** with the method of **Coniglione et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach simulating a particle movement along each the particle track through the geometric model in integer based increments. **Kaufman et al.** teaches simulating a particle movement along each the particle track through the geometric model in integer based increments (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivation

for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 21.1 above.

Silver does not expressly teach simulating a particle movement along the primary direction of movement. **Tumer** teaches simulating a particle movement along the primary direction of movement. (CL 6, L6-14). The motivation for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 21.1 above.

Silver does not expressly teach simulating a particle movement until a position when the material of the next element is substantially different from the material of the starting element; the position corresponding to at least one of the particle being captured, scattered and exited from the geometric model. **Tumer** teaches simulating a particle movement until a position when the material of the next element is substantially different from the material of the starting element; the position corresponding to at least one of the particle being captured, scattered and exited from the geometric model (CL6, L1-4; CL 6, L6-14). The motivation for combining the method of **Silver** with the method of **Tumer** is presented in paragraph 21.1 above.

Silver does not expressly teach the particle corresponding to a beta or gamma emission emanating from the radiation source during the radiation therapy. **Coniglione et al.** teaches the particle corresponding to a beta or gamma emission emanating from the radiation source during the radiation therapy (CL1, L47-56). The motivation for combining the method of **Silver** with the method of **Coniglione et al.** is presented in paragraph 21.1 above.

28.2 As per claim 42, **Silver, Kaufman et al., Fox et al., Coniglione et al., Tumer, Moscovitch** and **Nelson et al.** teach the method of claim 40. . **Silver** does not expressly teach

the step of converting the pixels into the uniform volume elements further comprises the step of proportionally converting a volume and shape of the pixels into a corresponding volume and shape of the uniform volume elements. **Kaufman et al.** teaches the step of converting the pixels into the uniform volume elements further comprises the step of proportionally converting a volume and shape of the pixels into a corresponding volume and shape of the uniform volume elements (Fig. 2; Fig 3; CL1, L66 to CL2, L11; CL2, L34-57). The motivation for combining the method of **Silver** with the method of **Kaufman et al.** is presented in paragraph 21.2 above.

28.3 As per Claim 43, it is rejected based on the same reasoning as Claim 40, supra. Claim 43 is computer readable medium claim reciting the same limitations as Claim 40, as taught throughout by **Silver, Kaufman et al., Fox et al., Coniglione et al., Tumer, Moscovitch.** and **Nelson et al.**

29. Claim 41 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Silver** (U.S. Patent 6,078,681) in view of **Kaufman et al.** (U.S. Patent 5,101,475), and further in view of **Fox et al.** (U.S. Patent 6,083,167), **Coniglione et al.** (U.S. Patent 6,589,502), **Tumer** (U.S. Patent 5,821,541), **Moscovitch** (U.S. Patent 5,498,876) and **Nelson et al.** (U.S. Patent 6,212,540)and **Schoolman** (U.S. Patent 5,493,595).

29.1 As per claim 41, **Silver, Kaufman et al., Fox et al., Coniglione et al., Tumer, Moscovitch** and **Nelson et al.** teach the method of claim 40. **Silver** does not expressly teach the step of generating a plurality of axial slices of the treatment volume. **Schoolman** teaches the

step of generating a plurality of axial slices of the treatment volume (CL9, L64-66). The motivation for combining the method of **Silver** with the method of **Schoolman** is presented in paragraph 22.1 above.

Allowable Subject Matter

30. Claims 11, 12 and 24 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

31. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dr. Kandasamy Thangavelu whose telephone number is 703-305-0043. The examiner can normally be reached on Monday through Friday from 8:00 AM to 5:30 PM.

If attempts to reach examiner by telephone are unsuccessful, the examiner's supervisor, Kevin Teska, can be reached on (703) 305-9704. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-305-9600.

K. Thangavelu
Art Unit 2123
July 29, 2004

KEVIN J. TESKA
SUPERVISORY
PATENT EXAMINER